STANDARD PRACTICE

FOR THE

TESTING OF VOLATILE ORGANIC EMISSIONS FROM VARIOUS SOURCES USING SMALL-SCALE ENVIRONMENTAL CHAMBERS

*(Supercedes previous versions of small-scale environmental chamber testing portion of **California Specification 01350**)*

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California Department of Health Services

ON BEHALF OF:

THE CALIFORNIA SUSTAINABLE BUILDING TASK FORCE

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State of California
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FOREWORD

Background of this Practice

The development of California's first building-related environmental specification started in early 2000, when the Department of General Services' (DGS's) Procurement Division was in the process of issuing a request for bids for a three-year, $60 million open office systems furniture contract. To address this issue, the several state agencies worked with DGS, the systems furniture industry, and private consultants to issue a benchmark environmental specification for procuring open office systems furniture. This specification was issued in December 2000, and included testing and selection criteria for indoor air quality as well as requirements for recycled contents and lighting.

The specification developed for open office systems furniture was used as the basis for developing an environmental specification for screening building materials by the design-build teams of a 1.5 million ft^2, five-office building complex in Sacramento known as the Capitol Area East End Complex (CAEEC). This specification was entitled *Special Environmental Requirements, Specifications Section 01350*, and included emissions-testing procedures, maximum allowable concentrations for selected VOCs, minimum recycled content requirements, and certification of recycled materials. After the successful implementation of *Section 01350* at the CAEEC, the original CAEEC-specific language was rewritten for wide use on other projects including the Collaborative for High-Performance Schools (CHPS) and is available on the Internet. It is also incorporated in DGS's Standard Agreement for all professional architectural and engineering services.

Need for Revising the Indoor Air Quality Portion of *Section 01350*

Section 01350 received wide acceptance from numerous manufacturers of building materials due to its flexibility, relative low cost, and the fact that it is the only health-based building material specification.

As laboratories started to implement *Section 01350* on a wide scale, it became apparent that certain sub-sections of this specification needed to be expanded. For example, the sub-section on sample receiving and handling has now been revised; the section on laboratory methods and procedures has been expanded; a new sub-section has been added detailing the laboratory reporting requirements; an informative section has been added providing useful information on TVOC calculations as well as Prop 65 chemicals. No changes have been made to the pass/fail criteria.

Highlights of this Practice

This practice requires:

- Specific procedures for specimen receiving, handling, and preparation
- Conditioning of test specimens for 10 days at 23±2°C and 50±10% RH, followed by a 96-hr test
- Sample collection, 24, 48 and 96 hr, following completion of 10-day conditioning period, based on small chamber tests as per ASTM Standard D5116-97
- Identification of the following chemicals of concern as listed by Cal-EPA:

1. Chemicals with established Chronic Reference Exposure Levels (CRELs). A CREL is an airborne concentration level that would pose no significant health risk to individuals indefinitely exposed to that level. CRELs are based solely on health considerations and are developed from the best available data in the scientific literature.
2. Chemicals listed as: (a) probable or known carcinogens, or (b) reproductive toxicants.

- Ten most abundant compounds.

The emissions factors calculated from the small chamber tests for each of the identified chemicals of concern are then used to calculate the "modeled" indoor air concentrations for a standard office space or a classroom application using default ventilation rates, quantities (surface area, fault length, or units) of the material to be installed, and space volumes. *Section 01350* requires that modeled indoor air concentration of any chemical 96-hr after the 10-d conditioning period, not exceed half of the CREL, with the exception of formaldehyde. For formaldehyde, no single product's modeled concentration can contribute more than half of the total maximum 33µg/m^3 (27 ppb) concentration limit for this chemical. The 33µg/m^3 guideline is based on Cal-EPA's current acute 1-hour Reference Exposure Level (REL) of 94 µg/m^3 (76 ppb) extrapolated to an 8-hour exposure period.

Sustainable Building Task Force

Section 01350 has been developed and adopted under the auspices of the California Sustainable Building Taskforce, a group representing over 40 state agencies and departments. This Task Force has been charged to implement Executive Order D-16-00 that established the state's sustainable building goals. Under the new administration, the responsibility of leadership of this Task Force has been assumed by the State Architect, Mr. Stephan Castellanos. The Task Force continues to meet regularly.

Since the majority of Section 01350 relates to laboratory practices that clearly fall under the expertise of the Department of Health Services' Indoor Air Quality Branch (DHS/IAQ), the Task Force has assigned the DHS/IAQ as the entity in charge of coordinating efforts with other state environmental agencies to revise, update, and maintain Section 01350 as well as measure its equivalency against other testing programs. The mission of DHS/IAQ is to "develop [voluntary] guidelines for the reduction of exposure to volatile organic compounds (VOC) from [building materials]" (Health and Safety Code §105405) and to "coordinate efforts to assess, protect, and enhance indoor environmental quality" (HSC §105425). It should be noted that the DHS/IAQ is not authorized to "certify" VOC testing protocols.

DISCLAIMER

The mention of commercial products or services, their source, or their use in connection with material presented in this report is not to be construed as actual or implied endorsement of such products or services by the State of California.

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SECTION 1

BACKGROUND INFORMATION

1.1 Scope

1.1.1 This practice applies to any material belonging to a product category generally used within an enclosed indoor environment. This includes, as examples, paints, other architectural coatings, sealants, adhesives, wallcoverings, floor coverings, wood paneling and furniture components used in public and commercial office buildings, schools, medical buildings, residences and other building types. The practice is only applicable to products that can be tested whole or by representative sample in small-scale environmental chambers.

1.1.2 This practice applies to newly manufactured products before they are used in construction.

1.1.3 This practice establishes the procedures for product sample collection, emission testing, indoor concentration modeling and documentation requirements associated with the analyzing the emissions of volatile organic chemicals from various sources using small-scale environmental chambers.

1.1.4 This practice also establishes performance criteria for specific chemicals of interest.

1.1.5 This practice lists target chemicals and their maximum allowable concentrations. However, this practice does not purport to address all of the safety, health, comfort (e.g., odor) and performance concerns, if any associated with its use. Users of this practice may establish additional safety, health, comfort and other performance conditions and determine the applicability of regulatory requirements prior to use.

1.2 References

1.2.1 ASTM Standards

D 1356-00a Standard Terminology Relating to Sampling and Analysis of Atmospheres

D 5116-97 Standard Guide for Small-Scale Environmental Chamber Determinations of Organic Emissions from Indoor Materials/Products

D 5197-03 Standard Test Method for Determination of Formaldehyde and Other Carbonyl Compounds in Air (Active Sampler Methodology)

D 6196-97 Standard Practice for Selection of Sorbents, Sampling and Thermal Desorption Analysis Procedures for Volatile Organic Compounds in Air

D 6345-98 Standard Guide for Selection of Methods for Active, Integrative Sampling of Organic Compounds in Air

1.2.2 Other Documents

Alevantis, L. 2003. *Building Material Emissions Study*. California Integrated Waste Management Board Publication Number 433-03-015. The report is accessible at http://www.ciwmb.ca.gov/GreenBuilding/Specs/Section01350/METStudy.htm

ASHRAE Standard 62-2001. *Ventilation for Acceptable Indoor Air Quality*, American Society of Heating, Refrigerating, and Air Conditioning Engineers, Atlanta, GA

California Department of Health Services. 2002a. Standard Operating Procedure: The Determination of Volatile Organic Compounds in Building Material Emission by Gas Chromatography/Mass Spectrometry. SOP No. 116/R0 Environmental Health Laboratory Branch. Berkeley, CA. April 17, 2002.

California Department of Health Services. 2002b. Standard Operating Procedure: Small-Scale Environmental Chamber for Material Testing. SOP No. 114/R0 Environmental Health Laboratory Branch. Berkeley, CA. April 9, 2002.

California Department of Health Services. 2002c. Standard Operating Procedure: Aldehyde Emissions from Building Materials. SOP No. 115/R0 Environmental Health Laboratory Branch. Berkeley, CA. March 20, 2002.

Cal/EPA, ARB list of Toxic Air Contaminants (TACs). The current version of this list is accessible at http://www.arb.ca.gov/toxics/taclist.htm

Cal/EPA OEHHA Safe Drinking Water and Toxic Enforcement Act or 1986 (Proposition 65). The current versions of these lists are accessible at http://www.oehha.ca.gov/prop65/prop65_list/newlist.html

Cal/EPA OEHHA list of chemicals with noncancer chronic Reference Exposure Levels (RELs). The current version of this list is accessible at http://www.oehha.ca.gov/air/chronic_rels/AllChrels.html

European Committee for Standardization. 2002. PrEN 13419-1. Building Products, Determination of the Emissions of Volatile Organic Compounds. Part 1: Emissions Test Chamber Method

European Committee for Standardization. 2002. PrEN 13419-3. Building Products, Determination of the Emissions of Volatile Organic Compounds. Part 3: Procedure for Sampling, Storage of Samples and Preparation of Test Specimens

Reference Specifications for Energy and Resource Efficiency, Section 01350 Special Environmental Requirements. The current version of this Specification is accessible at http://www.eley.com/specs/index.htm and http://www.chps.net/manual/documents/Sec_01350.doc

U.S. EPA. Method TO-1. 1984. Method for the Determination of Volatile Organic Compounds in Ambient Air Using Tenax Adsorption and Gas Chromatography/Mass Spectrometry (GC/MS). *Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air, Second Edition* (EPA/625/R-96/010b). This method is accessible at http://www.epa.gov/ttn/amtic/airtox.html

U.S. EPA. Method TO-17. 1997. Determination of Volatile Organic Compounds in Ambient Air Using Active Sampling Onto Sorbent Tubes. *Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air, Second Edition* (EPA/625/R-96/010b). This method is accessible at http://www.epa.gov/ttn/amtic/airtox.html

1.3 Terminology

1.3.1 Acronyms and Abbreviations

ARB – Air Resources Board, Cal/EPA

ASTM – American Society for Testing and Materials

Cal/DHS – California Department of Health Services

Cal/EPA – California Environmental Protection Agency

CIWMB – California Integrated Waste Management Board, Cal/EPA

DNPH – 2,4-Dintrophenylhydrazine

EF – Emission factor

EPA – U.S. Environmental Protection Agency

GC/MS – Gas chromatography/mass spectrometry

HAP – Hazardous Air Pollutant

HPLC – High performance liquid chromatography

IAQ – Indoor air Quality

ISO – International Standards Organization

LOQ – Limit of quantitation, lower

MDF – Medium density fiberboard

MFC – Mass flow controller

MSDS – Material safety data sheet

OEHHA – Office of Environmental Health Hazard Assessment, Cal/EPA

OSB – Oriented strand board

REL – Reference exposure level

RH – Relative humidity in percent

TAC – Toxic Air Contaminant

TD-GC/MS – Thermal desorption GC/MS

TIC – Total ion-current chromatogram

TVOC – Total volatile organic compounds

UV – Ultraviolet wavelength

VCT – Vinyl composition tile

VOC – Volatile organic compound

1.3.2 **Definitions**

1.3.2.1 Air change rate – Ratio of volume of conditioned air brought into the emission test chamber or building space per unit time to the chamber or building space volume

1.3.2.2 Air flow rate – Air volume entering the emission test chamber per unit time

1.3.2.3 Air velocity – Air speed over the surface of the test specimen

1.3.2.4 Aldehydes – Formaldehyde, acetaldehyde and other carbonyl compounds detectable by derivatization with DNPH and analysis by HPLC

1.3.2.5 Area specific flow rate – Ratio of the inlet air flow rate to the nominal surface area of the product or the product test specimen

1.3.2.6 Background concentration – VOC concentrations in emission test chamber in the absence of a product test specimen

1.3.2.7 Chain-of-custody – Document providing written evidence of transfer of a product sample, air sample, or another document from one organization to another organization or from one individual to another individual within the same organization. Document is signed and dated by each party involved in the transfer

1.3.2.8 Chronic REL – Noncancer chronic reference exposure level developed by Cal/EPA OEHHA. These are inhalation concentrations to which the general population, including sensitive individuals, may be exposed for long periods (10 years or more) without the likelihood of serious adverse systemic effects other than cancer.

1.3.2.9 Concentration – Mass of VOC per unit air volume expressed at standardized conditions for temperature and humidity (i.e., 298^{o} K, 101.3 kPa)

1.3.2.10 Data acquisition system – System used to monitor, acquire and store data defining the environmental conditions for an emission test

1.3.2.11 Emission factor – Mass of VOC emitted from a specific unit area of product surface per unit time. Other unit measures such as product mass or length may be used as appropriate

1.3.2.12 Emission rate – Mass of VOC emitted by a entire product or test specimen per unit time

1.3.2.13 Emission test chamber – Non-contaminating enclosure of defined volume with controlled environmental conditions for inlet air flow rate, temperature and humidity used for determination of VOC emissions from product test specimens

1.3.2.14 Loading factor – Ratio of the nominal exposed surface area of the product or the test specimen to the volume of the building space or the emission test chamber

1.3.2.15 Manufacturer's identification number – Unique product identifier from which a manufacturer is be able to determine the product name, product category or subcategory, manufacturing location, date of manufacture, production line, and other pertinent identifying information for the product

1.3.2.16 Mass flow controller – Electronic device based on principle of thermal conductivity used to control the flow rate of air entering the emission test chamber and the flow rate of air passing through a sampling device

1.3.2.17 Product category – General group of similar products intended for a particular application and performance, such as VCT, laminated wood flooring, broadloom carpet, sheet vinyl flooring, plywood, OSB, interior paint, etc.

1.3.2.18 Product subcategory – Group of products within a product category having similar chemistry, construction, weight, formulation and manufacturing process and which may have a similar VOC emissions profile

1.3.2.19 Representative product sample – A product sample which is representative of the product manufactured and produced under typical operating conditions.
1.3.2.20 Sampling interval – Time over which a single air sample is collected
1.3.2.21 Sampling period – Established time for collection of air sample from emission test chamber
1.3.2.22 Scan mode – Operation of an electron impact GC/MS to continually and repeatedly scan masses between m/z 35 – 350, or some other range
1.3.2.23 Sorbent tube – Solid phase sampling device through which a sample of chamber exhaust air at controlled flow rate is passed to capture VOCs. Device typically contains Tenax-TA, or equivalent, as primary sorbent material backed up by higher surface area sorbent material to quantitatively capture the most volatile VOCs
1.3.2.24 Specific emission rate – Emission rate normalized to the area, mass or length of a product (i.e., equivalent to emission factor)
1.3.2.25 Test specimen – Portion of representative sample prepared for emission testing in an emission test chamber following a defined procedure
1.3.2.26 Total-ion-current chromatogram – Chromatographic representation of a GC/MS analysis produced as the sum of all of the scanned masses between m/z 35 – 350, or some other range
1.3.2.27 TVOC – Sum of the concentrations of all identified and unidentified VOCs between and including n-pentane through n-heptadecane (i.e., $C_5 – C_{17}$) as measured by GC/MS TIC method and expressed as a hydrocarbon equivalent value
1.3.2.28 Ventilation rate – Same as air change rate
1.3.2.29 VOCs - Carbon-containing compounds (excluding carbon monoxide, carbon dioxide, carbonic acid, metallic carbides and carbonates and ammonium carbonate) with vapor pressures at standard conditions approximately ranging between those for n-pentane through n-heptadecane. For the purposes of this practice, formaldehyde and acetaldehyde are considered to be VOCs
1.3.2.30 Zero time – Time establishing the beginning of an emission test

1.3.3 **Symbols and Units**

Symbol	Description	Units
A	Projected surface area	M^2
A	Air change rate	h^{-1}
C_i	Concentration of VOC_i	$\mu g\ m^{-3}$
EF_A	Emission factor, area specific	$\mu g\ m^{-2}\ h^{-1}$
ER	Emission rate	$\mu g\ h^{-1}$
L	Product loading factor	$m^2\ m^{-3}$
Q	Air flow rate	$m^3\ h^{-1}$

Symbol	Description	Units
q_A	Area specific flow rate	$m^{-3}\ h^{-1}\ m^{-2}\ (m\ h^{-1})$
SER_A	Area specific emission rate	$\mu g\ m^{-2}\ h^{-1}$
T	Time after start of test	h or day
V	Volume	M^3
vf_B	Building ventilated volume fraction	Unitless

SECTION 2

COLLECTION, PACKAGING, SHIPMENT, & DOCUMENTATION OF PRODUCT SAMPLES

2.1 Sample Collection

2.1.1 Purpose

Guidelines are established for the collection, handling and documentation of product samples to ensure the samples being tested are reliable, representative, uncontaminated, and well preserved. The guidelines are generally consistent with European Committee for Standardization (2002) PrEN 13419-3.

2.1.2 Personnel

2.1.2.1 Personnel in charge of sample collection must perform the task carefully and conscientiously. If the sampling is done improperly, the sample is in error and any subsequent analysis is invalid.

2.1.2.2 Because of the importance of proper sampling, individuals engaged in sample collection and handling must be qualified by training and experience and possess a thorough understanding of the relevant practices and techniques or, at a minimum, be under the direct supervision of such an individual.

2.1.3 Representative Sample

2.1.3.1 Samples selected for testing shall be representative of the product manufactured and produced under typical operating conditions.

2.1.4 Sample Preservation

2.1.4.1 Due to the adsorptive and absorptive nature of most products being tested, special care shall be taken to prevent contamination of the product sample from any external source, such as solvent-containing products, prior, during and subsequent to the sample collection procedure.

2.1.4.2 Samples must be stored immediately after collection in airtight, moisture-proof containers/packaging to prevent contamination and to preserve their chemical integrity by preventing subsequent VOC emission losses.

2.1.5 Location of Sampling

The product type and manufacturing process determine the optimal sampling location as described in the sampling procedures. The sampling location/site shall be selected to allow for reproducible, easy access to a representative cross section of the product category. The location shall be documented.

2.1.6 **Sample Age**

2.1.6.1 With the exception of containerized products, samples shall be collected and shipped from the manufacturing facility within one week (7 days) of the actual production completion date or as otherwise specified below for individual product categories. Containerized products (i.e., paints, sealants, adhesives, and other wet products) shall be collected and shipped within three months of production.

2.1.6.2 Samples shall be shipped within 24 hours of actual collection.

2.1.6.3 Timing of sample collection shall be coordinated between the manufacturing facility and the testing laboratory to ensure that testing of samples can commence within 4 ± 1 week of the actual production date, except for containerized products for which testing of samples shall commence within 2 weeks of receipt at the laboratory (maximum 3 months, 2 weeks from actual production date).

2.1.6.4 Testing of dry products may commence prior to the 3 weeks from production to meet specific project deadlines. The manufacturer shall provide a written request to the laboratory for early initiation of a test.

2.1.6.5 The schedule for sample collection, shipping, specimen preparation, and testing is summarized in Table 7.1.

2.1.7 If cutting or other preparation of a test specimen at a testing laboratory is exceptionally difficult or requires highly specialized equipment, a fully prepared test specimen may be fabricated by the manufacturer and shipped to the laboratory following all other applicable procedures. Such fabrication procedures shall be fully documented and reported . All cutting and other tools used to prepare test specimen shall be cleaned properly to avoid sample contamination.

2.1.8 **Sample Collection Procedures – Tile, strip, panel and plank products less than or equal to 2-feet wide including VCT, resilient floor tile, linoleum tile, wood floor strips, parquet flooring, laminated flooring, modular carpet tile, etc**.

2.1.8.1 Representative product samples shall be collected directly from the packing line if possible. A minimum of four representative tiles, strips or planks, each with a minimum surface area of at least 64 square inches, shall be collected. A single 18 x 18-inch or 24 x 24-inch carpet tile or ceiling panel, for example, may be cut into four equal squares. The tiles, strips or planks shall be stacked tightly together face to back and immediately wrapped with two layers of heavy-duty aluminum foil so the air space within the package is minimized and the seams are crimped to create an airtight seal. If necessary to assure the package is air tight, the seams of the outer layer of aluminum foil can be sealed with clear packaging tape (e.g., 3M Scotch Brand, 3850 series). The foil package shall be labeled (Section 2.1.8.2) and then placed in a clear polyethylene or Mylar bag. The bag shall be sealed with a tie wrap. No more than one hour shall elapse between the time of collection and packaging.

2.1.8.2 A sample label, listing the manufacturer, sample ID, product name, and date and time of sample collection, shall be affixed to both the outside of the foil-wrapped product package and the outside of the bag.

2.1.8.3 Samples collected more than 24-hours from production shall be obtained from consumer packages. A package containing stacked pieces shall be opened and a

sufficient number of pieces shall be selected and withdrawn from the center of the stack to prepare the sample as described in Section 2.1.8.1.

2.1.9 **Sample Collection Procedures – Sheet and roll goods greater than 2-feet wide including broadloom carpet, sheet vinyl, sheet linoleum, carpet cushion, wallcovering, other fabric, etc**.

2.1.9.1 Samples collected within 24-hours of actual production can be taken directly from the end of the product roll. Samples collected more than 24-hours from production shall be taken a minimum of 2 yards or at least two full roll circumferences (i.e., roll diameter x 3.14 x 2) from the end of the roll.

2.1.9.2 A strip approximately one-foot wide shall be cut across the width of the roll. At least one foot shall be discarded from each end of the strip. The remaining material shall be cut into approximate 12 x 12-inch squares. A minimum of four squares is required. The squares shall be stacked tightly together face to back, and immediately wrapped with two layers of heavy-duty aluminum foil and packaged as described in Sections 2.1.8.1 and 2.1.8.2.

2.1.9.3 Wallcovering and other fabric may be collected as a full or partial production roll. In this case, the roll shall have at least 10 layers of material. The roll shall be wrapped in two layers of heavy-duty aluminum foil and packaged as described in Sections 2.1.8.1 and 2.1.8.2.

2.1.10 **Sample Collection Procedures – Rigid panel products greater than 2-feet wide including gypsum board, other wall paneling, insulation board, OSB, MDF, plywood, particleboard, etc**.

2.1.10.1 A representative panel shall be collected directly from the production line if possible. Samples collected more than 24-hours from production shall be obtained from a stack by selecting a panel that is positioned at least three panels down from the top of the stack.

2.1.10.2 For large panel products, the sample shall be taken at least 6 inches away from all edges of a panel. Within this boundary, the panel shall be cut into approximate 12 x 12-inch squares. A minimum of four squares is required. The squares shall be stacked tightly together face to back, immediately wrapped with two layers of heavy-duty aluminum foil and packaged as described in Sections 2.1.8.1 and 2.1.8.2.

2.1.11 **Sample Collection Procedures – Fiberglass insulation batt products**

2.1.11.1 Fiberglass insulation batt shall be collected directly from the packing line if possible. Cut four 2-foot long sections across the width of the batt. Stack these together, compress them to reduce the air volume and carefully wrap them in two layers of heavy-duty aluminum foil. Package as described in Sections 2.1.8.1 and 2.1.8.2.

2.1.11.2 To collect fiberglass insulation batt from a consumer package, remove one or two pieces from the center of the selected package. Cut these into 2-ft long sections and package four sections in two layers of heavy-duty aluminum foil and as described in Sections 2.1.8.1 and 2.1.8.2. Alternately, an unopened consumer package may be shipped to the laboratory.

2.1.12 **Sample Collection Procedures – Containerized products including adhesives, sealants, paints, other coatings, primers and other "wet" products**.

2.1.12.1 Paints, other coatings and primers can be supplied in original, standard 1-quart or 1-gallon consumer containers.

2.1.12.2 Adhesives can be supplied in their consumer packaging such as an applicator tube or can if these are small (i.e., less than 1 gallon). Alternately, the samples of adhesives can be collected in clean, unused paint cans (1-pint or 1-quart size). Special care is required to assure these samples are representative of the larger batches from which they are collected. Containers shall be filled so there is minimal unfilled headspace above or below the adhesive. The collection procedure shall be documented.

2.1.12.3 Samples of containerized products sent to a laboratory shall be accompanied by a Material Safety Data Sheet (MSDS) and a specification sheet that describe the products, list the major chemical ingredients, identify the intended uses and describe the application methods.

2.1.12.4 If specialized tools are required to apply a containerized product to a substrate (e.g., a specific notched trowel not readily obtainable in a hardware store) these tools also shall be supplied to the laboratory.

2.1.12.5 A sample label, listing the manufacturer, sample ID, and date and time of sample collection, shall be affixed to the outside of the product container.

2.1.12.6 Testing laboratories reserve the right to return the unused portion of any containerized product to the organization supplying the product for testing.

2.2 Packaging and Shipment of Samples

2.2.1 Product samples provided in standard manufacturer's packaging or as otherwise proscribed above shall be carefully packaged in a cardboard box or other shipping container suitable for air shipment so that the sealed polyethylene or Mylar bag and the foil layers will not damaged or punctured during shipment.

2.2.2 Only one product shall be placed in a shipping container. If multiple samples are shipped simultaneously, they shall be placed in separate containers.

2.2.3 The product sample shall be sent from the collection site by airfreight within 24 hours of collection. Third business day delivery is an acceptable shipment method. Where possible, the sample shall be shipped via a carrier recommended by the testing laboratory. See Table 7.1 for schedule.

2.2.4 Samples being shipped from foreign countries shall be sent by airfreight using an expeditious service to accommodate extra transit time and customs procedures.

2.2.5 A chain of custody form described below (Section 2.3) shall be prepared for each sample. The form, listing key product information, shall be completed, signed and attached to the outer bag containing the packaged sample using a clear plastic window envelope or equivalent method.

2.3 Chain-of-Custody Documentation

2.3.1 A completed and signed chain of custody form shall accompany each product sample.

2.3.2 The chain of custody form shall be printed as a multi-layered carbonless copy form or if a single-layered form is used, each signatory shall sign, date and transmit the original and retain a photocopy for their record.

2.3.3 The chain of custody form shall include, at a minimum, the following information:

2.3.3.1 *Manufacturer/Company Details* – Name, Street Address, City, State/Province, Country, Zip/Postal Code

2.3.3.2 *Contact Details* – Contact Name, Title, Phone Number, Fax Number, Email Address

2.3.3.3 *Sample Details* – Sample ID, Product Category, Product Subcategory (if applicable), Product Name, Manufacturers Identification Number, Date Manufactured, Sample Collection Location, Sample Collection Date and Time, Sample Collected By, Number of Sample Pieces

2.3.3.4 *Shipping Details* – Packed By, Shipping Date, Carrier, Airbill Number (Carrier and Airbill Number may be filled in by Laboratory upon receipt).

2.3.3.5 *Ship to Laboratory* – Name, Street Address, City, State/Province, Country, Zip/Postal Code, Phone Number, Fax Number

2.3.3.6 *Laboratory Receiving Details* – Received By, Received Date, Condition of Shipping Package, Condition of Sample, Assigned Laboratory Material tracking Number

2.3.3.7 *Signature Tracking Details* – Relinquished By, Received By, Signature, Company, Date and Time

2.4 Rejection of Samples by Laboratory

2.4.1 A testing laboratory shall have the right to reject a product sample for testing due to, but not limited to, any of the following reasons:

2.4.2 Shipping package is severely damaged upon arrival.

2.4.3 Product container (i.e., external bag, foil package, can, tube, etc) is damaged upon arrival.

2.4.4 Chain of Custody form is missing or incomplete.

2.4.5 Product sample arrives with insufficient time to initiate testing within the required time frame as given in Section 2.1.6.3.

2.4.6 When a product sample is rejected, the testing laboratory shall inform the manufacturer within two days of the decision and provide the reason for rejection.

2.4.7 The manufacturer has the right to collect a new sample and resubmit it for testing, subject to the conditions described within this practice. All costs for recollection and shipment shall be the responsibility of the manufacturer.

2.5 Receipt of Samples by Laboratory

2.5.1 On the same day a package is received from the shipping company, the laboratory's sample custodian or other authorized personnel shall inspect the package and product container for visible signs of damage that could potentially affect the integrity of the product sample.

2.5.2 The product container (i.e., external bag, foil package, can, tube, etc) shall not be opened at this time.

2.5.3 The sample custodian shall note the condition of the package and container on the chain-of-custody form and sign and date the form.

2.5.4 If a package or container is significantly damaged or the other criteria are not met, the laboratory shall reject the sample as described in Section 2.4.

2.5.5 Valid samples shall be assigned a unique laboratory ID number. The sample information and the ID number shall be entered into the laboratory's sample-tracking database.

2.6 Storage of Samples by Laboratory Prior to Testing

2.6.1 Prior to testing, samples shall be stored in their original unopened containers in a conditioned space at typical indoor conditions.

2.6.2 The samples shall be protected from chemical contamination and exposure to temperatures in excess of 25^{o} C. Samples shall not be refrigerated or stored at reduced temperature.

SECTION 3

LABORATORY SAMPLE PREPARATION AND ANALYSES

3.1 Test Specimen Preparation

3.1.1 For product assemblies (e.g., wall paint primer and finish coat, wallcoverings, and floor systems where the finish material is applied to a substrate, with or without the use of adhesives), the individual products comprising the assembly shall be tested separately. If all individual products meet the emissions criteria established herein, no further testing is required. For assemblies where one component, such as an adhesive, does not meet the criteria, the products may be tested together with assembly preparation following the manufacturer's recommended procedures.

3.1.2 Products manufactured to arrive on site preassembled (i.e., adhesive impregnated wallpaper or adhesive applied floor tiles) shall be tested as an a single unit, that is, the manufacturer is not required to submit separate samples of the primary material and adhesive for testing.

3.1.3 The test specimen dimensions given in this section are for illustrative purposes. The dimensions shall be optimized for small-scale test chambers with volumes of 50 to 100 L operating at 1 air change per hour to achieve the loading factor specified in Table 7.2. See also Section 3.8.2 for more information.

3.1.4 For products not covered in this specification, it may be necessary to develop alternate procedures for preparation of test specimens. If procedures other than described in this section are used, they shall be fully described and reported.

3.1.5 A fraction of the specimens shall be prepared in duplicate from the same product sample. The fraction of duplicates is determined by the laboratory's quality assurance plan, but at a minimum is one duplicate for every ten samples.

3.1.6 Completion of specimen preparation and placement of the test specimen in the conditioning environment shall be regarded as the starting time for the VOC emission test (i.e., zero time).

3.1.7 If special substrates and/or edge sealing materials (i.e., gypsum board and aluminized tape) are required for specimen preparation, appropriate tests shall be conducted to determine background concentrations of VOCs for these materials. They shall not emit VOCs above the limits specified for the chamber background. Additionally, an attempt shall be made to use materials that do not emit measurable amounts of any target VOC of concern. In some cases, it may be acceptable to perform background tests for batches or lots of substrate materials.

3.2 Preparation of Paint Test Specimens[1]

3.2.1 Apply "flat" and "eggshell" wall paints to standard 5/8" thick gypsum board (USG Sheetrock brand). The substrate size shall be appropriate to achieve the specified loading factor (Table 7.2). For the purposes of this and subsequent sections on specimen preparation, a 6" x 6" (15.2 cm x 15.2 cm) substrate size is assumed. Pre-condition the substrate to the test humidity condition by maintaining it for at least 24 hours at 23 ± 2° C and 50 ± 10% RH while ventilated with clean air. Just prior to painting, accurately weigh (±0.1 g) substrate, mask borders ¼" on all sides with tape to avoid paint dripping on edges and leave 5.5" x 5.5" (0.0195 m^2) center area for paint. Accurately measure (±2 mm) the dimensions of the area to be painted. Alternative approaches for protecting the edges may be acceptable and shall be reported if used.

3.2.1.1 Apply paint using standardized roller procedure that simulates application of paint in building by this technique. For most wall paint applications, use a 4" wide 3/8" nap roller intended for smooth surfaces. Alternate methods shall be reported if used.

3.2.1.2 Thoroughly stir paint in container and transfer 100 mL of paint to heavy-duty aluminum foil disposable tray.

3.2.1.3 Completely saturate roller cover with paint by running roller back and forth in tray.

3.2.1.4 Apply paint to substrate using four strokes, two in vertical direction and two in horizontal direction, so entire area is uniformly covered. For most wall paints, use a single loaded roller application.

3.2.1.5 Remove tape mask from substrate and re-weigh substrate. Difference in weight before and after painting determines mass of applied paint and coverage in grams of wet paint per square meter of substrate surface.

3.2.1.6 Place substrate on 6" by 6" piece of sheet stainless steel to cover entirely the back surface. Attach substrate to stainless steel with strips of aluminized tape emitting no VOCs so only painted surface is exposed. *(Note: a variety of aluminized tapes are available including tapes manufactured specifically for cleanroom use. As specified in Section 3.1.7, appropriate background tests shall be performed to demonstrate selected tape is not a source of VOC contamination.)* For a blank specimen, similarly prepare an unpainted piece of gypsum board. Alternate procedures to cover unpainted surfaces of gypsum board may be acceptable and shall be reported if used.

3.2.1.7 Immediately transfer specimen to conditioning environment and record the time.

3.2.1.8 Where multiple coats of paint, which may include primer, are being tested, apply paints as described above and follow manufacturers' instructions for minimum or optimal drying time between coats. Report weight of test specimen prior to and after each coat of paint is applied. Hold specimen in conditioning environment between coats. The conditioning period begins immediately after application of final coat.

3.2.2 Apply "semi-gloss" and "gloss" paint to clean, 6" by 6", stainless steel sheet metal following procedure described above. A glass plate may be used as alternate substrate. Mask edges of substrate as described to create 5.5" by 5.5" painting area. Substrate shall be weighed immediately before and after painting.

[1] Specimen sizes are to be adjusted according to the chamber volume to achieve the specified loading factors. See Sections 3.1.3 and 3.8.2

3.3 Preparation of Adhesive Product Test Specimens[2]

3.3.1 Apply adhesive to clean, 6" by 6", stainless steel sheet metal or glass plate unless product is specifically designed to be applied to gypsum board. If the choice of substrate is optional, a sheet metal or glass plate shall be used. If substrate is gypsum board, use piece of substrate pre-conditioned for at least 24 hours at 23 ± 2°C and 50 ± 10% RH while ventilated with clean air.

3.3.1.1 Accurately weigh (±0.1 g) substrate before applying adhesive. If substrate is gypsum board, mask boarders with tape as described for paint application (Section 3.2.1). Accurately measure (±2 mm) the dimensions of the area to which the adhesive will be applied.

3.3.1.2 Thoroughly mix adhesive in container and apply to entire surface of substrate or masked area with notched trowel closely matching the dimensions of manufacturer's specified tool. Record the dimensions of the trowel.

3.3.1.3 Re-weigh substrate after removing tape mask from substrate, if applicable. Difference in weight before and after application determines mass of applied adhesive and coverage in grams of wet adhesive per square meter of substrate surface.

3.3.1.4 If substrate is porous material, complete preparation of test specimen by covering back and cut edges as described in Section 3.2.1.6.

3.3.1.5 Immediately transfer specimen to conditioning environment and record the time.

3.4 Preparation of Caulking Product Test Specimens

3.4.1 Apply caulks, sealants, adhesives and other products supplied in tube applicators or containers into a metal channel (aluminum, brass or stainless steel). The width and height of the metal channel shall match the intended diameter of the caulk bead, i.e., either ¼" or 3/8" and shall be 6" to 10" in length.

3.4.1.1 Accurately weigh (±0.1 g) and measure (±2 mm) metal channel before applying caulk.

3.4.1.2 Insert the container into a caulk gun. Cut the applicator tip to produce the desired bead width. Dispense approximately 100 g from the container and discard. Then, fill the metal channel with caulk using a single, smooth stroke of the gun. Wipe any excess caulk from the exterior of the channel.

3.4.1.3 Re-weigh the channel after applying the caulk. Difference in weight before and after application determines mass of applied caulk and coverage in grams of wet caulk per linear meter of a defined-size bead.

3.4.1.4 Immediately transfer specimen to conditioning environment and record the time.

3.5 Selection and Preparation of Dry Product Test Specimens[2]

3.5.1 The period of time between unpacking a product sample and preparation of the test specimen shall be as short as practical. The time between unpacking and placing the finished test specimen in the conditioning environment shall be no longer than 1 hour. Any exceptions shall be reported. The time of placement of the specimen in the conditioning environment shall be recorded.

3.5.2 All surface dimensions of specimens shall be accurately measured (±2 mm) after they are cut. In many cases, it also will be necessary to measure the thickness of the specimen. If

[2] Specimen sizes are to be adjusted according to the chamber volume to achieve the specified loading factors. See Sections 3.1.3 and 3.8.2

any portion of the surface is masked with aluminized tape, the actual exposed surface dimensions of the specimen shall be measured.

3.5.3 **Selection of test specimen from package containing stacked pieces of the product samples**: Open the packaging containing the product sample. Select a piece from the center of the stack in a random manner, i.e., do not purposefully select the piece based on any appearance characteristic. Cut the specimen from the center of the selected piece at least 1" away from the previously cut edges. Exceptions are products for which it may be important to incorporate a factory-finished edge into the VOC emission test (e.g., laminate counter top, acoustical ceiling panel, etc.) For these products, cut the specimen from the selected piece leaving one factory-finished edge.

3.5.4 **Selection of test specimens from sample rolls (e.g., wallcoverings and other fabrics)**: Open the package containing the product sample. Discard at least the outer two layers of the roll. Cut the test specimen from the remaining material at least 4" away from the factory-finished edges.

3.5.5 **Specimen preparation for sheet and tile type resilient flooring products**: Two methods are acceptable. Cut 6" by 6" square and attach to clean stainless steel sheet metal to cover entirely the back surface. Attach substrate to sheet metal with strips of low VOC aluminized tape so only 5.5" by 5.5" of the wear surface is exposed. Alternately, cut 6" by 6" square of the product and fit inside tray constructed of stainless steel sheet metal that provides tight fit at edges so only the primary wear surface of the specimen is exposed.

3.5.6 **Specimen preparation for vinyl wallcovering products**: Cut 6" by 6" square and attach to clean stainless steel sheet metal to cover entirely the back surface. Attach substrate to sheet metal with strips of low VOC aluminized tape so 5.5" by 5.5" of the primary face is exposed.

3.5.7 **Specimen preparation for woven and nonwoven fabric type products**: No substrate is required. Cut 6" by 6" square of the product and transfer directly to the conditioning environment. The exposed area for calculation of emission factors and room concentrations is considered to be the area of the primary face (i.e., 0.0232 m^2).

3.5.8 **Specimen preparation for composite wood products**: Cut 6" by 6" square being careful to avoid contamination of the specimen. For example, it may be necessary to use a paper or tape mask on the surface to minimize contamination from a mechanized saw. Attach substrate to clean stainless steel sheet metal with strips of low VOC aluminized tape so only 5.5" by 5.5" of the primary face is exposed.

3.5.9 **Specimen preparation for gypsum board and similar rigid wall panels**: Cut 6" by 6" square being careful to avoid contamination of the specimen. Attach substrate to clean stainless steel sheet metal with strips of low VOC aluminized tape so only 5.5" by 5.5" of the primary face is exposed.

3.5.10 **Specimen preparation for acoustical ceiling panels**: No substrate shall be used since both faces of suspended acoustical ceilings are typically exposed to room air. Cut 6" by 6" square of the product sample leaving one factory-finished edge intact and transfer directly to the conditioning environment. The exposed area for calculation of emission factors and room concentrations is considered to be the area of the primary face (i.e., 0.0232 m^2). This accounts for emissions from both the primary face and the back surfaces

and eliminates having to double the surface area of the primary face when doing modeling calculations for an occupied space

3.5.11 **Specimen preparation for carpet tile and broadloom carpet**: Cut 6" by 6" square of the product and fit inside tray constructed of stainless steel sheet metal that provides tight fit at edges so only the primary face is exposed.

3.5.12 **Specimen preparation for fiberglass batt insulation**: No substrate shall be used as an insulation specimen is tested with all surfaces exposed. Compress a section of batt using 6" by 6" metal template placed in the middle of the section. Cut around the perimeter of the template with a utility knife to produce a specimen with 6" by 6" primary face. Measure the thickness of the batt when expanded. The exposed area for calculation of emission factors and estimation of room concentrations is considered to be the area of one face (i.e., 0.0232 m^2). This accounts for emissions from the entire block i.e., the primary face, the back surface, and the sides and eliminates having to double the surface area of the primary face when doing modeling calculations for an occupied space. Alternately, calculate the volume of the insulation block and use it to calculate a volume-specific emission rate and to estimate room concentrations.

3.6 Preparation of Dry Product Test Specimen Assemblies[3]

3.6.1 **Laminates (all types) or wood veneers applied with adhesives**: Apply laminate or veneer to a MDF core using the manufacturer's recommended adhesive and procedures. If a specimen of appropriate size is produced by a manufacturer specifically for VOC emission testing, it is recommended that the core be fully encapsulated so all six sides are covered with the finish material. Attach a 6" by 6" square of laminate or veneer material to clean, 6" by 6", stainless steel sheet metal with strips of low VOC aluminized tape so only 5.5" by 5.5" of the primary surface is exposed.

3.6.2 **Sheet and tile type resilient flooring applied with adhesives**: Apply 6" by 6" square of product to clean, 6" by 6", stainless steel sheet metal or glass plate using the manufacturer's recommended adhesive and procedures. Seal the edges of the assembly with strips of low VOC aluminized tape so only 5.5" by 5.5" of the primary surface is exposed.

3.6.3 **Carpet tile and broadloom carpet applied with adhesives**: Apply 6" by 6" square of product to clean, 6" by 6", stainless steel sheet metal or glass plate using the manufacturer's recommended adhesive and procedure. As it is not practical to seal the edges of the carpet in this situation, leave the edges of test specimen exposed.

3.6.4 **Vinyl and other wallcovering products applied with adhesives**: Apply 6" by 6" square of product to 6" by 6", 5/8"-gypsum board substrate (Section 3.2.1) using the manufacturer's recommended adhesive and procedures. Prior to preparation of the test specimen, gypsum board substrate shall be pre-conditioned for at least 24 hours at 23 +/- 2 degrees C and 50 +/- 10% RH while ventilated with clean air. Place assembly on 6" by 6" piece of sheet stainless steel to cover entirely the back surface. Attach assembly to stainless steel with strips of low VOC aluminized tape so only 5.5" by 5.5" of the primary face is exposed.

[3] Specimen sizes are to be adjusted according to the chamber volume to achieve the specified loading factors. See Sections 3.1.3 and 3.8.2

3.7 Conditioning of Test Specimens

Principle: The principle of conditioning is to maintain test specimens in clean air at controlled conditions of temperature and RH for a defined period of 10 days before initiating a 96-hour test in a small-scale test chamber at more precisely controlled conditions. In this manner, the final VOC measurements determining the suitability of a product are made after the specimen has been exposed for a total of 14 days. Fourteen days represents an early, but realistic, time for building first occupancy after new construction or major renovation. At the 14-day time point, the emissions of VOCs from most products primarily will be dependent upon the characteristic diffusion rate of the VOCs within the material and the concentration of the VOCs in the bulk material and should change slowly from day to day and from week to week. Thus, minor differences in product sample age at the time of collection should be partially or wholly compensated for by use of a 10-day conditioning period and any minor surface contamination not directly related to the content of VOCs in the bulk material should be eliminated. Also, the potential effect of external mass transfer resistance on the emission rates of most VOCs should be diminished substantially after 10 days of conditioning. Incorporation of conditioning into a product testing method is described in Section 10.3, European Committee for Standardization (2002) PrEN 13419-1.

3.7.1 **Apparatus:** Conditioning can be accomplished by different approaches using different apparatus. Product specimens can be maintained for the entire 14-day period in the emission test chambers. A potentially less expensive approach utilizes a specially constructed facility. This facility is based on an isolated room constructed entirely with low emitting and low sorbing interior surfaces such as stainless steel sheet metal. The room is supplied with acceptably clean air and maintained at controlled temperature and RH conditions. The test specimens are maintained in separate metal containers with ventilation air drawn into each container from the room.

3.7.1.1 **Emission test chambers:** If the emission test chambers are used for conditioning, the apparatus and procedures described in Section 3.8 shall apply.

3.7.1.2 **Conditioning room with specimens in separate containers:** The room shall be supplied with clean air at a minimum of 2 air changes per hour. Specimens shall be placed in individual clean metal containers with a volume of at least 10-L. Containers shall be of sufficient size so air freely circulates through the container and all emitting surfaces of prepared specimens are exposed to circulating air. Air shall be drawn through the containers with a vacuum system at a flow rate that provides an area specific flow rate nearly equivalent (i.e., within ± 20%) to the area specific flow rate achieved in the emission test chamber.

3.7.2 **Clean air supply:** The air used to supply the conditioning environment shall contain low levels of VOCs and shall be filtered for particulate matter. It may be suitable to supply a conditioning room environment with outside air that has passed through a filtration system consisting of a bed of granulated activated carbon and a particle filter. The VOC content of the supply air shall not exceed 5 $\mu g/m^3$ for any individual compound including formaldehyde and 25 $\mu g/m^3$ for TVOC.

3.7.3 **Temperature and relative humidity control:** The temperature and humidity of the air to which specimens are exposed during the conditioning period shall be maintained within ranges of 23 ± 2^o C and 50 ± 10% RH.

3.7.4 **Verification of conditions:** The airflow rates to a conditioning room and to individual containers used for conditioning shall be measured and recorded on a periodic basis

according to the laboratory's quality assurance plan. The temperature and relative humidity of a conditioning room or of emission test chambers used for conditioning shall be continuously monitored and recorded using temperature/RH probes and a data acquisition system. The air used for conditioning periodically shall be sampled and analyzed for VOCs, aldehydes and TVOC on at least a monthly basis according to the laboratory's quality assurance plan.

3.7.5 **Time:** Placement of a test specimen in the conditioning environment establishes the beginning of the test period. This critical time shall be recorded and all subsequent times for transfer of the specimen to the test chamber and collection of air samples from the chamber shall be scheduled relative to this initial zero time. A ± 2% deviation in transfer time and sampling times is allowed. Thus, transfer from the conditioning environment to the test chamber shall occur at an elapsed time of 10 days ± 5 hours.

3.8 Environmental Chamber Testing

3.8.1 **Principle**: The principle of the test is to determine the specific emission rates of VOCs emitted from prepared specimens of building products. The test is conducted in a small-scale environmental chamber at specified constant conditions of temperature, relative humidity, ventilation rate and product loading factor. The chamber is considered to be a constantly stirred tank reactor. As the air in the chamber is fully mixed, VOC concentrations measured at the chamber exhaust are representative of air concentrations in the chamber. From the airflow rate into the chamber, the VOC concentration, and the exposed surface area of the specimen, an area-specific emission rate or emission factor is calculated using the state-state form of the mass-balance model. The chamber test is conducted following the guidance of ASTM Standard D 5116, "Guide for Small Chamber Environmental Chamber Determination of Organic Emissions from Indoor Materials/Products." European Committee for Standardization (2002) PrEN 13419-1 provides additional guidance.

3.8.2 **Test Conditions**: The test shall be conducted at the conditions and within the limits specified in Table 7.2. Standard conditions for the purpose of calibrating flow measurement devices and calculating all flow rates shall be 25^{o} C (298^{o} K) and one atmosphere pressure (101.3 kPa). The chamber volume shall be between 50 and 100 L. The chamber shall be ventilated at 1 ± 0.05 air changes per hour. The loading factor shall be optimized to produce an area specific flow rate approximately equal to the area specific flow rate for the product in the modeled scenarios (Section 4.2). The central value of 0.5 m^2 of exposed specimen surface area per m^{-3} chamber volume results in an area specific flow rate of 2 m^3 h^{-1} m^{-2} (m h^{-1}), which is close to the value for many materials in both the classroom and office building scenarios. A loading factor of 0.3 to 0.7 m^2 m^{-3} is allowed for all materials. Specimen sizes are to be adjusted according to the chamber volume to achieve the specified loading factors.

3.8.3 **Duration**: The chamber test shall last 96 hours. Sealing of the chamber lid following insertion of the product specimen into the chamber establishes the zero time for the start of the test.

3.8.4 **Apparatus and Facilities**: The apparatus and facilities shall be constructed to maintain the test specimen at the specified conditions within a non-contaminating and low sorption environment.

3.8.4.1 **Clean air supply and flow control**: A clean air generator or high purity air cylinders shall be used to supply pressurized clean, dry air. The flow rate of the supply air to a chamber shall be regulated and monitored with electronic mass flow controllers (MFCs), or equivalent, with an accuracy of ± 2 % at 1 Lpm, or better, and capable of continuously maintaining the flow within ± 5 % of the specified value. MFCs shall be calibrated periodically according to the Laboratory's quality assurance plan. At a minimum, flow measurement devices shall be calibrated on an annual basis against NIST traceable standards. As the humidity of the supply air is maintained by mixing dry and saturated gas streams, generally two mass flow controllers are required per chamber (i.e., one for the dry stream and one for the wet stream). The dry and wet streams shall be mixed before the supply air enters the chamber.

3.8.4.2 **Chamber and materials**: The chamber volume shall be between 50 and 100 L. The chamber shall be constructed of stainless steel or glass. Stainless steel chambers shall have electro-polished, or equivalent, interior surfaces. Either rectangular or cylindrical shapes are acceptable. The chamber shall be designed as a single-pass system without recirculation of chamber air. The chamber shall be operated at a slight positive pressure relative to the room to prevent the entrainment of room air. The chamber inlet and exhaust shall be positioned and designed to ensure complete mixing of chamber air. The chamber lid shall have a non-contaminating, non-sorbing gasket and a closure mechanism to create an airtight seal. Other materials introduced into to the chamber (e.g., racks and probes) shall be constructed of non-contaminating materials such as stainless steel or glass.

3.8.4.3 **Background concentrations** in the empty chamber ventilated at 1.0 air changes per hour shall not exceed 2 $\mu g\ m^{-3}$ for any individual VOC, and 25$\mu g\ m^{-3}$ for TVOC.

3.8.4.4 **Temperature and humidity control**: The temperature of the chamber shall be maintained at 23 ± 1^{o} C throughout the 96-h test. All surfaces of the chamber shall be held at the same temperature so that the temperature inside the chamber is uniform. Typically, this is accomplished by placing the chamber inside a temperature-controlled environment such as an incubator or a dedicated room. The humidity of the chamber air shall be maintained at 50 ± 10% RH. As wet products (e.g., water-based paints) will have 10 days of prior conditioning, the RH of the chamber air should be nearly equivalent to the RH of the inlet air. Thus, the humidity can be established by controlling the humidity of the inlet air. Generally, this is accomplished by mixing equivalent flows of dry and water saturated air streams. Water used in bubblers to saturate gas streams shall be free of organic solvents and contaminants (i.e., HPLC grade or equivalent).

3.8.4.5 **Monitoring and data acquisition**: The temperature and relative humidity for a chamber shall be measured continuously and independently of the systems for controlling temperature and humidity. The measurements shall be made inside the chamber or immediately at the chamber exhaust using electronic probes. The probes shall be calibrated periodically according the laboratory's quality assurance plan. At a minimum, these probes shall be calibrated on an annual basis against NIST traceable standards. Chamber inlet flow rates, temperature and relative humidity shall be recorded using a computer-based data acquisition system. At a minimum, these data shall be recorded at 5-minute intervals.

3.8.5 **Procedures**

3.8.5.1 **Chamber cleaning and preparation**: Prior to reuse, the chamber shall be fully disassembled and washed. At a minimum, the chamber and components shall be washed with a dilute solution of laboratory detergent in warm water, thoroughly rinsed with clean water and dried. The reassembled chamber shall be operated at the test conditions for a minimum of three full air changes prior to making a background measurement or introducing a test specimen.

3.8.5.2 **Background measurement**: Chamber background measurements shall be made on a regular basis according to the laboratory's quality assurance plan. At a minimum, the background of VOCs and aldehydes shall be determined prior to each third use of a chamber. VOC and aldehyde samples are to be collected as described in Section 3.8.6 to provide lower quantitation limits of at least 2 $\mu g\ m^{-3}$ for individual VOCs and 25 $\mu g\ m^{-2}$ for TVOC.

3.8.5.3 **Specimen loading**: Test specimens shall be taken directly from the conditioning facility and placed in a cleaned test chamber minimizing the time the specimen is exposed to laboratory air. Generally, this time shall not exceed 15 minutes. In a rectangular chamber with flat surfaces, the specimen may be placed directly on the floor of the chamber without additional support. In a horizontally oriented cylindrical chamber, a wire rack is used to hold the specimen near the midpoint of the chamber. A wire rack may also be used in a rectangular chamber. There shall be sufficient space for chamber air to circulate freely around the exposed face of the specimen. The specimen loading factor shall be 0.3 - 0.7 $m^2\ m^{-3}$.

3.8.5.4 **Chamber air leakage**: The air leakage of the chamber shall be determined immediately after loading a test specimen. This is accomplished by measuring the flow rate at the chamber exhaust and comparing this to the supply airflow rate. The flow measurement device shall have low pressure drop. Bubble flow meters and low-pressure drop rotameters are suitable for use. The exhaust flow rate shall be within 10% of the inlet flow rate by this method.

3.8.5.5 **Duplicate tests**: A fraction of the tests shall be conducted in duplicate using specimens prepared from the same product sample. The fraction of duplicates is determined by the laboratory's quality assurance plan, but at least one duplicate for is required every ten tests.

3.8.6 **Air Sampling**

3.8.6.1 **Sampling schedule**: Chamber air samples shall be collected at average elapsed times of 24, 48 and 96 hours after initiating the chamber test.

3.8.6.1.1 **At 24 and 48 hours**, only samples for formaldehyde and TVOC analyses are required to be collected. These first measurements, when compared to the corresponding 96-h measurements, are used to determine whether the chamber concentrations remained relatively constant or declined slowly throughout the test. Temporal variations or fluctuations outside of the normally expected range (e.g., ± 25%) likely indicate that a test parameter was uncontrolled or an analysis was incorrect. In this case, the cause of the variations shall be determined and the test repeated if necessary.

3.8.6.1.2 **At an average time of 96 ± 2 hours** after initiating the test, samples for the full characterization of VOC emissions shall be collected.

3.8.6.2 Sampling media

3.8.6.2.1 **VOC sampling media** for individual VOCs and TVOC shall consist of thermally desorbed, solid-phase sorption tubes. Refer to ASTM documents D6196 and D 6345, U.S. EPA Methods TO-1 and TO-17 and Cal/DHS SOP No 114-116/RO for guidance. The samplers shall be capable of quantitatively collecting VOCs with a broad range of functional groups and volatilities approximately within the volatility range of n-pentane through n-heptadecane (C_5 - C_{17}). Minimal losses of analytes (i.e., <5%) due to breakthrough shall occur. This can be accomplished by the use of sampling tubes containing two or more sorbent materials in series, with the highest surface area material used as the backup to prevent the breakthrough of the most volatile compounds. Typical sorption tubes contain Tenax-TA as the primary sorbent backed up by carbonaceous sorbent(s). Before use, samplers shall be conditioned by thermal desorption. Samplers taken from refrigerated storage shall be warmed to room temperature prior to use.

3.8.6.3 **Sampling media** for formaldehyde, acetaldehyde and other low molecular weight aldehydes through butanal (C_4 aldehydes) shall consist of cartridges containing a solid support material (e.g., silica gel) treated with an acid solution of 2,4-dinitrophenylhydrazine (DNPH) as a derivatizing reagent. Refer to ASTM document D 5197 and Cal/DHS SOP No 114-116/RO for guidance. Samplers shall be warmed to room temperature prior to use.

3.8.6.4 **Flow control**: Sampling flow rates shall be regulated with electronic mass flow controllers, or equivalent, with an accuracy of ±2 % full scale, or better, and capable of continuously maintaining the flow during sampling within ±5 % of the specified value.

3.8.6.5 **Sampling procedures**: Air samples shall be collected directly from the chamber exhaust at the specified elapsed times. A short manifold with multiple ports and a maximum length of 6 in (15 cm) may be used at the exhaust to allow simultaneous collection of multiple samples. No other tubing is allowed between the chamber exhaust and the sampler inlet. The DNPH cartridge is placed downstream of the VOC sorption tubes to reduce the chance of VOC sample contamination with residual acetontrile that may be present in the DNPH cartridge. The total sampling flow rate at any time shall not exceed 75% of the inlet flow rate. The start and stop times and the sampling flow rates shall be recorded. A unique identification number shall be assigned to each air sample.

3.8.6.6 **Duplicate samples**: A fraction of the samples shall be collected in duplicate. The fraction of duplicates is determined by the laboratory's quality assurance plan, but is at least one duplicate is required for every ten samples.

3.8.6.7 **Sampler storage**: Following collection, air samples shall be sealed in clean airtight containers and stored at reduced temperature in a dedicated refrigerator or freezer. Samples shall be analyzed as soon as practical after collection. Use unexposed samplers as storage blanks.

3.9 Chemical Analyses

3.9.1 **Principle**: Chamber air samples are analyzed using instrumental methods that are capable of positively identifying individual VOCs and quantifying them using multi-point calibrations prepared using pure standards. The methods provide sufficient sensitivity and accuracy to reliably quantify individual VOCs at concentrations of 2 $\mu g\ m^{-2}$, or less.

3.9.2 Analytical Instruments

3.9.2.1 VOCs and TVOC: Sorbent tube samples for individual VOCs and TVOC shall be analyzed by thermal desorption GC/MS (TD-GC/MS). The thermal desorber desorption and inlet parameters shall be optimized to obtain quantitative recovery of VOCs in the range defined in Section 3.8.6.2.1. The GC column and oven temperature parameters shall be optimized for the analysis of volatiles. The MS shall be an electron impact instrument operated in the scanning mode over a mass range of at least *m/z* 35-350.

3.9.2.2 Formaldehyde, acetaldehyde and other low molecular weight aldehydes: Aldehyde samples shall be analyzed by HPLC equipped with a UV detector and an analytical column providing full resolution of the formaldehyde hydrazone derivative from unreacted DNPH in a sample.

3.9.3 Methods for Individual VOCs

3.9.3.1 The analytical methods for individual VOCs shall be based on ASTM D 6196, "Standard Practice for Selection of Sorbents, Sampling and Thermal Desorption Analysis Procedures for Volatile Organic Compounds in Air." Other relevant practices are EPA Methods TO17, "Determination of Volatile Organic Compounds in Ambient Air Using Active Sampling Onto Sorbent Tubes" and TO-1, "Determination of Volatile Organic Compounds in Ambient Air Using Tenax Adsorption and Gas Chromatography/Mass Spectrometry (GC/MS)" or equivalent methods. Standards and chamber samples shall be analyzed using identical conditions.

3.9.3.2 The analytical methods for formaldehyde, acetaldehyde and other low molecular weight aldehydes shall be based on ASTM Standard D 5197, "Standard Test Method for Formaldehyde and other Carbonyl Compounds in Air (Active Sampler Methodology)" or an equivalent method. It is recognized that unsaturated low molecular weight aldehydes such as acrolein are not accurately determined by this method. Higher molecular weight aldehydes approximately beginning with butanal can be analyzed by the method for individual VOCs.

3.9.4 **TVOC Method**

3.9.4.1 Because the TVOC results are highly dependent upon the details of the analytical method and because there are substantial variations in the TIC response of VOCs with different chemical functionality, the analysis of TVOC is a semi-quantitative measure that is inherently less accurate than the calibrated measurement of individual VOCs.

3.9.4.2 There are no standard methods for the analysis of TVOC. Consequently, the TVOC method selected by the laboratory must be fully described so that comparability and potential biases with respect to other TVOC methods readily can be determined.

3.9.4.3 A laboratory may find it useful to determine TVOC by the same basis method employed to sample and analyze individual VOCs.

3.9.4.4 The TVOC method must span a retention time interval consistent with the analysis of individual VOCs. Use toluene as the reference compound for calculating TVOC mass. See Section 8.1 for non-mandatory guidance on the TVOC method.

3.9.5 **Identification of Individual VOCs**

3.9.5.1 The identification of an individual VOC by GC/MS shall be determined by comparing the chromatographic retention time and mass spectrum of the unknown to the corresponding parameters for the pure compound analyzed on the same instrument using identical methods. Matching retention times and mass spectra provide positive, confirmed identifications. All VOCs of concern occurring on the referenced lists (Section 4.1) shall be positively identified.

3.9.5.2 If no high quality match is obtained, the unknown spectrum is compared to spectra contained in the latest version of the NIST electronic database. A trained analyst shall decide if the identification is likely based on the match quality and the reasonableness of the retention time. Compounds identified by this procedure shall be clearly indicated. If no highly probable match is obtained, the compound shall be labeled as an unknown.

3.9.5.3 Aldehyde hydrazone derivatives analyzed by HPLC shall be identified by matching the chromatographic retention times of the unknowns with the retention times of derivatives of the pure compounds analyzed on the same instrument using identical methods.

3.9.6 **Analytical Calibrations**

3.9.6.1 All target VOCs of concern shall be quantified by GC/MS based on multi-point calibrations prepared using pure compounds. If possible, other positively identified VOCs shall be quantified by the same method. An internal standard calibration method is recommended. A minimum of four points shall be used. Target analytes shall be introduced onto sorbent tubes as gas or liquid standards and then analyzed using methods identical to those used for the analysis of chamber samples. Analyze calibration standards or perform full calibrations at least once every three months or more frequently to ensure accuracy for the analyses.

3.9.6.2 Individual VOCs not positively identified by GC/MS shall be quantified using appropriate surrogates. Fully describe the method. Use toluene as the reference compound for calculating compound mass. VOCs quantified by this surrogate method shall be clearly indicated.

3.9.6.3 Aldehydes analyzed by HPLC shall be quantified based on multi-point calibrations prepared from hydrazone derivatives of the pure compounds. Standards and samples

shall be analyzed using identical methods. At least one standard shall be analyzed with each batch of samples.

3.9.7 **Lower Limits of Quantitation (LOQ)**

3.9.7.1 A lower LOQ often is quantitatively defined as the analyte mass that produces a response that is 10 times higher than the instrumental noise level or is 10 times the standard deviation for repeated analyses of a low level standard. A lower LOQ that is higher than this absolute value may be defined based on practical considerations.

3.9.7.2 TVOC: The lower LOQ shall be 25 μg m^{-3}, or better.

3.9.7.3 Individual VOCs including formaldehyde and acetaldehyde

3.9.7.3.1 The lower LOQ for VOCs appearing on list of chemicals of concern (Section 4.1.1 through 4.1.5) shall be 2 μg m^{-3}, or better.

3.9.7.3.2 The lower LOQ for non-listed VOCs (Section 4.1.6) shall be 5 μg m^{-3}, or better.

3.9.8 A LOQ verification sample shall be analyzed after each calibration. Target analytes shall be introduced onto sorbent tubes as gas or liquid standards at or below the level of quantitation and then analyzed using methods identical to those used for the analyses of chamber samples.

3.10 Calculations

3.10.1 **Calculation of Emission Factors**

3.10.1.1 Since the chamber measurements are made starting on the 11th day and ending on the 14th day after preparation of the test specimen (i.e., 24-, 48- and 96-h sampling time points following a 10-day conditioning period) when chamber concentrations are expected to change slowly with time, the steady state form of the mass-balance equation shall be used for analysis of the chamber data (ASTM document D 5116).

3.10.1.2 The area specific emission rate or emission factor, EF_{Ai} (μg m^{-2} h^{-1}), at a given time, t (h), after placing a test specimen in the chamber shall be calculated using Equation 1. The inlet flow rate, Q (m^3 h^{-1}), is the measured flow rate of air into the chamber. The chamber concentration, C_{it} (μg m^{-3}), is the concentration of a target VOC_i, formaldehyde and other carbonyl compounds measured at time t. The chamber background concentration, C_{i0} (μg m^{-3}), is the corresponding concentration measured with the chamber operating without a test specimen or with an appropriate substrate. The exposed projected surface area of the test specimen in the chamber, A_C (m^2), is determined from the measurements made at the time of specimen preparation.

$$EF_{Ai} = Q \times (C_{it} - C_{i0}) / A_C \quad (1)$$

3.10.1.3 Volume, length and mass specific emission rates or emission factors, EF_V, EF_L or EF_M (μg m^{-3} h^{-1}, μg m^{-1} h^{-1} or μg kg^{-1} h^{-1}), can be calculated using Equation 1 by substituting the appropriate parameter used to quantify the material specimen (i.e., volume in cubic meters, length in meters or mass in kilograms).

3.10.2 **Calculation of Estimated Building Concentrations**

3.10.2.1 Building concentrations can be calculated on a case-by-case basis using input parameters for the amount of installed product, the size of the space and the air change

rate that are specific to the architectural project under consideration. In order to evaluate and compare products for use in a wide range of building products, concentrations also can be calculated for selected building scenarios as described below.

3.10.2.2 Building concentrations are estimated based on the measured VOC emission factors, the amount of material to be installed in the building and the building parameters for volume, ventilation rate and ventilated volume fraction. Steady state conditions with respect to emission rates and building ventilation shall be assumed in making the prediction. Additional assumptions are zero outdoor concentrations, perfect mixing within the building and no net losses of VOC from air due to other effects such as irreversible or net sorption on surfaces (i.e., net sink effects) and chemical reactions.

3.10.2.3 The projected surface area of an installed material by product category and the building parameters to be used in the calculation of estimated VOC concentrations are established by this practice for two model building scenarios, a standard school classroom and a standard commercial office (Section 4.2).

3.10.2.4 The estimated building concentration, C_{iB} (µg m^{-3}), of a target VOC_i shall be calculated using Equation 2. The area specific emission rate or emission factor, EF_A (µg m^{-2} h^{-1}), at 96 hours after placing a test specimen in the chamber (14 days total exposure time) is multiplied by the exposed surface area of the installed material in the building, A_B (m^2). This quantity is divided by the flow rate of outside ventilation air, Q_B (m^3 h^{-1}), calculated as the product of the building volume, V_B (m^3), the air change rate, a_B (h^{-1}) and the ventilated volume fraction, vf_B, which is assumed to be 0.9.

$$C_{Bi} = (EF_{Ai} \times A_B) / (V_B \times a_B \times 0.9) \quad (2)$$

3.10.2.5 Given the building area specific ventilation calculated as (V_B x a_B x 0.9) / A_B, the building concentration also is calculated as the emission factor divided by the area specific flow rate (m^3 h^{-1} m^{-2} or m h^{-1}).

3.10.2.6 In some cases, it may be necessary to calculate the results using the volume, length or mass of a product to be installed in a building and the corresponding volume, length or mass specific emission rate.

SECTION 4

TARGET CHEMICALS AND MAXIMUM ALLOWABLE CONCENTRATION

4.1 Target VOCs

4.1.1 VOCs emitted by products appearing on agency lists of toxic substances are considered to be chemicals of concern. The emissions of these VOCs shall be quantified using pure standards as described in Sections 3.9.6.1 and 3.9.6.3. Chemicals of concern include known or probable human carcinogens, reproductive/developmental toxins, and systemic toxins with noncancer chronic effects in the latest published editions of the following lists:

4.1.2 Cal/EPA OEHHA list of chemicals for which noncancer chronic Reference Exposure Levels (RELs) have been established. Chronic RELs are inhalation concentrations to which the general population, including sensitive individuals, may be exposed for long periods (10 years or more) without the likelihood of serious adverse systemic effects other than cancer. The chronic REL list is accessible at http://www.oehha.ca.gov/air/chronic_rels/AllChrels.html. The most recent list is reproduced as Table 7.3. Generally, VOCs with chronic RELs also appear on the TAC list.

4.1.3 Cal/EPA OEHHA Safe Drinking Water and Toxic Enforcement Act or 1986 (Proposition 65). These lists of known or probable human carcinogens and reproductive/developmental toxins are accessible at http://www.oehha.ca.gov/prop65/prop65_list/newlist.html.

4.1.4 Cal/EPA, ARB list of Toxic Air Contaminants (TACs). This list is accessible at http://www.arb.ca.gov/toxics/taclist.htm. The TAC list includes all substances on the EPA list of Hazardous Air Pollutants plus additional compounds.

4.1.5 The focus of this practice is on VOCs on the above lists that can be sampled and analyzed by the methods specified in the practice. As stated in Sections 3.8.6.2.1 and 3.8.6.2.2, many VOCs within the volatility range of n-pentane through n-heptadecane (C_5 - C_{17}) can be analyzed by TD-GC/MS and low molecular weight aldehydes through butanal and higher can be analyzed using HPLC. Thus, there are numerous chemical substances on the chronic REL lists that are not VOCs (e.g., metals, acids and pesticides) that are not required to be analyzed for this practice. In most cases, these other substances are not expected to be emitted by products used indoors in buildings.

4.1.6 Non-listed VOCs that are abundant in the emissions from a product specimen shall also be quantified. At a minimum, the ten most abundant VOCs, which may include listed compounds, shall be quantified. If pure standards are not readily available, abundant, non-listed VOCs may be quantified using surrogates as described in Section 3.9.6.2.

4.2 IAQ Concentration Modeling

4.2.1 **Principle**: The purpose of IAQ concentration modeling is to convert the VOC emission factor results into airborne concentrations that are relevant to potential indoor inhalation exposures of building occupants. The calculation is accomplished using the steady-state mass balance model described in Equation 2 (Section 3.10.2.4) and making several simplifying assumptions (Section 3.10.2.2). The model requires inputs for the amount of installed product, the volume of the space and the outdoor air ventilation rate.

4.2.2 **Area specific flow rate**: The relationship that determines, to a first-order approximation, the airborne concentration in the test chamber and in all built environments given a specific emission factor is the flow rate of outdoor ventilation air per unit area of product. This parameter is termed the area specific flow rate and has units of $m^3\ h^{-1}\ m^{-2}$ ($m\ h^{-1}$). It

is also obtained from the ratio of the air change rate to the loading factor (sometimes described as N/L) with the same units.

4.2.3 **Standardized building scenarios**: This practice specifies standardized building scenarios for typical product classes (e.g., floor coverings, wall coverings and paint, suspended acoustical ceilings, etc.) and typical building types (i.e., schools and public/commercial office buildings). The product usages and the size and ventilation rate parameters for the buildings establish area specific flow rates to be used for the estimation of indoor VOC concentrations**.**

4.2.4 **School classroom scenario**: Use a 24-ft wide by 40-ft long classroom with an 8.5-ft high ceiling. Use a ventilation rate of 0.9 h^{-1}. This is a weekly average assuming 40 hours per week of ventilation system operation at 3.0 h^{-1} and 128 hours per week at 0.2 h^{-1} due to infiltration. The 3.0 h^{-1} value is approximately equivalent to the ASHRAE 62-2001 ventilation guideline of 15 cubic feet per minute (cfm) per occupant for 27 occupants in this space. Assume that only 90% of the room volume of 231 m^3 is ventilated at this rate due to occupancy of the space by cabinetry, furnishings and other room contents. The calculations result in floor and ceiling surface area of 89.2 m^2. A net wall area of 94.6 m^2 is calculated based on the total wall area minus the area of the door and two windows. The school classroom parameters, surface areas of major product classes, and area specific flow rates for these materials selected for use in this practice are presented in Table 7.4. These parameters shall be used to calculate indoor VOC concentrations for school classrooms.

4.2.5 **Office space scenario**: Assume an enclosed windowless office with floor dimensions of 10-ft by 12-ft and a 9-ft high ceiling. Assume a ventilation rate of 0.75 h^{-1}. This is the approximate weekly average assuming 55 hours per week of ventilation system operation at 1.7 h^{-1} and 113 hours per week at 0.3 h^{-1} due to infiltration. Assume that only 90% of the volume is ventilated at this rate due to occupancy of the space by partitions, furnishings and other contents. The office parameters, surface areas of major product classes, and area specific flow rates for these materials selected for use in this practice are presented in Table 7.5. These parameters shall be used to calculate indoor VOC concentrations for offices.

4.3 Maximum Allowable Concentrations

It is assumed there are likely multiple sources of many individual VOCs in a building. Thus, an individual product is allowed to contribute no more than one-half the lowest concentration of interest in a building. To determine acceptability of the emission results, the estimated building VOC concentrations are compared to one-half their corresponding chronic RELs. The single exception is formaldehyde for which the calculated building concentration shall not exceed one-half of the indoor REL of 33 µg m^{-3} [4]. See Table 7.3 for a list of current CRELs. The most recent version of the CREL list shall be used, which is currently published at http://www.oehha.ca.gov/air/chronic_rels/AllChrels.html.

[4] Indoor REL developed by OEHHA

SECTION 5

REQUIRED ELEMENTS OF THE LABORATORY TEST REPORT

5.1 Required elements of the Laboratory Test Report

5.1.1 **Laboratory identification**: Name, address, phone number and other contact information for the laboratory.

5.1.2 **Manufacturer, product and sample identification**:

- Manufacturer and manufacturer contact name address and phone number
- Product name, product number, product category and subcategory (if applicable)
- Manufacturer's ID number and other identification numbers (if applicable)
- Manufacturing date, collection date, shipment date and date of arrival at laboratory
- Laboratory sample ID or tracking number.

5.1.3 **Test conditions**: Chamber volume, inlet air flow rate, average temperature and range, average relative humidity and range, exposed area of test specimen (or other relevant test specimen measurement parameter), chamber loading factor, test specimen preparation details, conditioning period start date and duration, and test period start date and duration.

5.1.4 **Data analysis procedures**: Analytical methods used to derive emission factors from measured chamber concentrations; Analytical methods and parameters used to calculate building concentrations from the emission factors including the assumed product area, building volume, building ventilation rate, and ventilated volume fraction.

5.1.5 **Test results**: For the 24- and 48- hr results list the formaldehyde and TVOC quantified in the chamber with their chamber concentrations and corresponding emission factors. For the 96-hr results list of all target VOCs (individual toxic and abundant VOCs, including formaldehyde and acetaldehyde – see Section 4.1) and TVOC quantified in the chamber with their chamber concentrations and corresponding emission factors.

Provide the following information:

5.1.5.1 CAS numbers for individual VOCs

5.1.5.2 Indicate which non-listed VOCs were quantified using surrogate compounds in lieu of pure compounds.

5.1.5.3 Identify those VOCs with chronic RELs and VOCs on the other lists of toxic substances (Section 4.1).

5.1.5.4 Provide estimated concentration for modeled building scenarios for all listed and non-listed compounds.

5.1.6 Certification of the Report: Name, position, signature and date of authorized laboratory personnel attesting to accuracy of provided information.

5.1.7 Report any additional facts, which may have influenced the test results. These include but are not limited to the following:

- Dates of most recent internal and external calibrations, methods and compounds used
- Dates of most recent proficiency evaluation(s) and corrective actions taken, if any
- Product sample manufacturing dates, collection dates, and shipment dates
- Any deviations of laboratory parameters from specified values
- Details of specimen preparation not covered above (i.e., application methods for paints and adhesives and preparation of assemblies)
- Mass quantity and coverage ($g\ m^{-2}$) of paint and adhesive
- Any other relevant observations.

5.1.8 Attach a copy of the completed and signed chain-of-custody (COC) form with the laboratory report.

SECTION 6

ACCEPTABLE ALTERNATIVES TO THIS PRACTICE

6.1 Test Results That Can Be Used As Alternatives to this Practice

At this time there are two alternatives that are acceptable for the purposes of this practice. The two alternatives are listed below:

6.1.1 Carpet emissions test results meeting all the requirements listed in Section 9 of this practice.

6.1.2 Test results meeting all the requirements described in this practice at no less than 168 hours (7 days) instead of the 336 hour (14-day) testing required by this practice are acceptable provided that: (a) the specimen remains in the same chamber for the duration of the 168-hr test; (b) samples for formaldehyde and TVOCs are collected and their corresponding chamber concentrations and emission factors are reported at 24, 48, 72, 96, and 120-hr; and (c) full speciation is performed at 168-hr according to the requirements described in this practice.

The 168-hr test results will **not** be acceptable instead of the 336-hr test for those chemicals, such as semi-VOCs, that may reach their maximum test chamber concentrations between 7 and 14 days.

Note: All times listed under Section 6.1.2 refer to elapsed times since placement of the specimen into the test chamber. Please note that Section 6.1.2 does not require a 10-day conditioning period as described under Section 3.7 of this practice and that the subsequent 96-hr test in the test chamber described under Section 3.8 is expanded in Section 6.1.2 to 168 hours.

SECTION 7

TABLES

Table 7.1 Sample collection and testing chronology for products

Event	Schedule
Dry Products (e.g., resilient flooring, carpet, wallcovering, etc.)	
Manufacturing date	Production date establishes initial time
Sample collection	No more than 7 days after production
Shipment to laboratory	Within 24 hours of sample collection and no more than 7 days after production
Commence laboratory testing[5]	Within 4±1 (3-5) weeks of production
Complete laboratory testing	Within 5-7 weeks of production
Containerized products (e.g., adhesive, sealant, paint, etc.)	
Manufacturing date	Production date establishes initial time
Shipment to laboratory	No more than 3 months after production
Commence laboratory testing	No more than 3 months, 2 weeks after production

Table 7.2 Chamber conditions for 96-h test period

Parameter	Symbol	Units	Value
Chamber volume	V	m^3	0.05 – 0.10
Loading factor[6]	L	$m^2\ m^{-3}$	0.5 ± 0.2
Air change rate	a	h^{-1}	1.0 ± 0.05
Area specific flow rate	q_A	$m\ h^{-1}$	1.4 – 3.3
Temperature	T	^oC	23 ± 1
Relative humidity	RH	%	50 ± 5

[5] Laboratory testing may commence prior to 3 weeks of production to meet a specific deadline. Early commencement must be requested by the manufacturer

[6] Specimen sizes are to be adjusted according to the chamber volume to achieve the specified loading factor range. See Sections 3.1.3 and 3.8.2

Table 7.3 All chronic inhalation Reference Exposure Levels (RELs) adopted by Cal/EPA OEHHA as of August 2003[7].

Substance	CAS No.	Chronic REL (µg/m^3)	Target system(s)
Acetaldehyde	75-07-0	9	Respiratory system
Acrolein	107-02-8	0.06	Respiratory system; eyes
Acrylonitrile	107-13-1	5	Respiratory system
Ammonia	7664-41-7	200	Respiratory system
Arsenic & arsenic compounds	7440-38-2	0.03	Development; Cardiovascular system; Nervous system
Benzene	71-43-2	60	Hematopoietic system; development; nervous system
Beryllium & beryllium compounds	7440-41-7	0.007	Respiratory system; immune system
Butadiene	106-99-0	20	Reproductive system
Cadmium & cadmium compounds	7440-43-9	0.02	Kidney; respiratory system
Carbon tetrachloride	56-23-5	40	Alimentary system; development; nervous system
Carbon disulfide	75-15-0	800	Nervous system; reproductive system
Chlorinated dioxins & dibenzofurans	1746-01-6 & 5120-73-19	0.00004	Alimentary system (liver); reproductive system; development; endocrine system; respiratory system; hematopoietic system
Chlorine	7782-50-5	0.2	Respiratory system
Chlorine dioxide	10049-04-4	0.6	Respiratory system
Chlorobenzene	108-90-7	1000	Alimentary system; kidney; reproductive system
Chloroform	67-66-3	300	Alimentary system; kidney; development
Chromium hexavalent: soluble except chromic trioxide		0.2	Respiratory system
Chromic trioxide (as chromic acid mist)		0.002	Respiratory system
Cresol mixtures	1319-77-3	600	Nervous system
Dichlorobenzene (1,4-)	106-46-7	800	Nervous system; respiratory system; alimentary system; kidney
Dichloroethylene (1,1)	75-35-4	70	Alimentary system
Diesel Exhaust		5	Respiratory system
Diethanolamine	111-42-2	3	Cardiovascular system; nervous system

[7] Most recent version shall be used as published at http://www.oehha.ca.gov/air/chronic_rels/AllChrels.html

Table 7.3 continued

Substance	CAS No.	Chronic REL ($\mu g/m^3$)	Target system(s)
Dimethylformamide (N,N-)	68-12-2	80	Alimentary system ; respiratory system
Dioxane (1,4-)	123-91-1	3,000	Alimentary system; kidney; cardiovascular system
Epichlorohydrin	106-89-8	3	Respiratory system; eyes
Epoxybutane (1,2-)	106-88-7	20	Respiratory system; cardiovascular system
Ethylbenzene	100-41-4	2,000	Development; alimentary system (liver); kidney; endocrine system
Ethyl chloride	75-00-3	30,000	Development; alimentary system
Ethylene dibromide	106-93-4	0.8	Reproductive system
Ethylene dichloride	107-06-2	400	Alimentary system (liver)
Ethylene glycol	107-21-1	400	Respiratory system; kidney; development
Ethylene glycol monoethyl ether	110-80-5	70	Reproductive system; hematopoietic system
Ethylene glycol monoethyl ether acetate	111-15-9	300	Development
Ethylene glycol monomethyl ether	109-86-4	60	Reproductive system
Ethylene glycol monomethyl ether acetate	110-49-6	90	Reproductive system
Ethylene oxide	75-21-8	30	Nervous system
Fluoride including Hydrogen Fluoride		13 F 14 HF	Bone and teeth; respiratory system
Formaldehyde	50-00-0	3[8]	Respiratory system; eyes
Glutaraldehyde	111-30-8	0.08	Respiratory system
Hexane (n-)	110-54-3	7000	Nervous system
Hydrazine	302-01-2	0.2	Alimentary system; endocrine system
Hydrogen chloride	7647-01-0	9	Respiratory system
Hydrogen cyanide	74-90-8	9	Nervous system; endocrine system; cardiovascular system
Hydrogen sulfide	7783-06-4	10	Respiratory system
Isopropanol	67-63-0	7,000	Kidney; development
Maleic anhydride	108-31-6	0.7	Respiratory system
Manganese & manganese compounds		0.2	Nervous system

[8] Indoor REL for this chemical has been established at 33 $\mu g/m^3$ (see Section 4.3)

Table 7.3 continued

Substance	CAS No.	Chronic REL (µg/m^3)	Target system(s)
Mercury & mercury compounds (inorganic)		0.09	Nervous system
Methanol	67-56-1	4,000	Development
Methyl bromide	74-83-9	5	Respiratory system; nervous system; development
Methyl chloroform	71-55-6	1,000	Nervous system
Methyl isocyanate	624-83-9	1	Respiratory system; reproductive system
Methyl t-butyl ether	1634-04-4	8,000	Kidney; eyes; alimentary system (liver)
Methylene chloride	75-09-2	400	Cardiovascular system; nervous system
Methylene dianiline (4,4'-)	75-09-2	20	Eyes; alimentary system (hepatotoxicity)
Methylene diphenyl isocyanate	101-68-8	0.7	Respiratory system
Naphthalene	91-20-3	9	Respiratory system
Nickel & compounds (except nickel oxide)		0.05	Respiratory system; hematopoietic system
Nickel oxide	1313-99-1	0.1	Respiratory system; hematopoietic system
Phenol	108-95-2	200	Alimentary system; cardiovascular system; kidney; nervous system
Phosphine	7803-51-2	0.8	Respiratory system; alimentary system; nervous system; kidney; hematopoietic system
Phosphoric acid	7664-38-2	7	Respiratory system
Phthalic anhydride	85-44-9	20	Respiratory system
Propylene	115-07-1	3,000	Respiratory system
Propylene glycol monomethyl ether	107-98-2	7,000	Alimentary system (liver)
Propylene oxide	75-56-9	30	Respiratory system
Selenium & selenium compounds (other than hydrogen selenide)		20	Alimentary system; cardiovascular system; nervous system
Styrene	100-42-5	900	Nervous system
Sulfuric acid	7664-93-9	1	Respiratory system
Tetrachloroethylene (perchloroethylene)	127-18-4	35	Kidney; alimentary system (liver)

Table 7.3 continued

Substance	CAS No.	Chronic REL ($\mu g/m^3$)	Target system(s)
Toluene	108-88-3	300	Nervous system; respiratory system; development
Toluene diisocyanates (2,4-&2,6-)		0.07	Respiratory system
Trichloroethylene	79-01-6	600	Nervous system; eyes
Triethylamine	121-44-8	200	Eyes
Vinyl acetate	108-05-4	200	Respiratory system
Xylenes (m-, o-, p-)	108-38-3, 95-47-6, 106-42-3	700	Nervous system; respiratory system

Table 7.4 Parameters to be used for calculation of VOC concentrations in classrooms

Parameter	Unit of Measure	Parameter Value	Area Specific Flow Rate ($m^3\ h^{-1}\ m^{-2}$)
Classroom Dimensions			
Length (40 ft)	m	12.2	
Width (24 ft)	m	7.32	
Ceiling height (8.5 ft)	m	2.59	
Volume	m^3	231	
Window & Door Area			
Windows (4 x 4 ft & 4 x 8 ft)	m^2	4.46	
Door (3 x 7 ft)	m^2	1.89	
Ventilation Parameters			
Air change rate	h^{-1}	0.9	
Ventilated volume fraction		0.9	
Outdoor air flow rate	$m^3\ h^{-1}$	187	
Surface Areas			
Floor & ceiling	m^2	89.2	
Net wall area	m^2	94.6	
Material Areas			
Flooring (all types)	m^2	89.2	2.10
Acoustical ceiling panels[9]	m^2	179	1.04
Wall paint & wallcoverings	m^2	94.6	1.98
Thermal insulation[9]			
Ceiling	m^2	89.2	2.10
Wall	m^2	94.6	1.98
Wall base (10 in)	m^2	9.68	19.3

[9] The emissions test accounts for emissions from both the primary face and the back of this product; only the primary face area is used for estimating concentrations.

Table 7.5 Parameters to be used for calculation of VOC concentrations in office buildings

Parameter	Unit of Measure	Parameter Value	Area Specific Flow Rate ($m^3 h^{-1} m^{-2}$)
Building Dimensions & Areas			
Volume	m^3	30.6	
Ceiling height (9 ft)	m	2.7	
Floor area	m^2	11.1	
Wall area	m^2	46.3	
Ventilation Parameters			
Air change rate	h^{-1}	0.75	
Ventilated volume fraction		0.9	
Outdoor air flow rate	$M^3 h^{-1}$	20.7	
Material Areas			
Flooring (all types)	m^2	11.1	1.86
Acoustical ceiling panels[10]	m^2	22.3	0.93
Wall paint and wallcoverings	m^2	46.3	0.45
Thermal insulation, ceiling[10]	m^2	11.1	1.86
Wall base (4 in)	m^2	1.25	18.4

[10] The emissions test accounts for emissions from both the primary face and the back of this product; only the primary face area is used for estimating concentrations.

SECTION 8

USEFUL INFORMATION

This is an informative appendix and not part of the required portion of this practice.

8.1 TVOC Calculations

The integrated TIC areas in a sample less the TIC area of the internal standard should be summed. The ratio of summed area to the area of an internal standard added to the sample should be calculated. This is termed the relative response (Rel. Resp.).

8.1.1 The Rel. Resp. should be multiplied by the internal standard mass to calculate an internal standard equivalent sample mass. If toluene-d8 is used as an internal standard, this value times the ratio of the density of toluene to toluene-d8 (i.e., 0.860/0.943) is the toluene-equivalent sample mass. For another internal standard, the following steps are applicable.

8.1.2 A toluene equivalent mass of TVOC should be determined based on an internal standard calibration performed with toluene. At least two calibration levels within the linear response range of toluene (e.g., 50 and 100 ng), are analyzed. For each level, the TIC response of the internal standard and toluene is divided by its corresponding mass in nanograms to produce a normalized area-per-unit mass response. Then area/mass relative responses are determined by dividing the normalized values for toluene by the normalized value for the internal standard. The results for the two levels are averaged to produce an average toluene response factor.

8.1.3 The internal standard equivalent sample mass should be divided by the average toluene response factor to produce a toluene-equivalent sample mass. Toluene-equivalent masses for laboratory and chamber blank samples are determined in the same manner. The appropriate blank value is subtracted from the sample mass, and the TVOC concentration is calculated by dividing the corrected sample mass by the sample volume.

8.2 Safe Exposure Levels for Carcinogens and Reproductive Toxicants

Carcinogenic or reproductive toxicants emitted from building materials should be minimized or eliminated. Because of the extensive listing of such chemicals under the California's Safe Drinking Water and Toxic Enforcement Act of 1986 (Proposition 65), Safe Harbor Levels (SHL) (i.e., the no significant risk levels for carcinogens and the maximum allowable dose level for chemicals causing reproductive toxicity) this list is used as a guidance in determining potentially harmful levels of such chemicals emitted from consumer products. To avoid confusion with the Proposition 65's Safe Harbor Levels, the numbers used in this guideline is designated as the "Safe Exposure Level" (SEL).

Carcinogen or reproductive toxicant SELs are concentrations derived by dividing the SHLs by average daily breathing rates as described below. Because most chemicals in consumer products offgas fairly quickly, exposure is short term and intermittent.

The use of the Proposition 65 SHLs for this assessment does not mean that the product necessarily complies with Proposition 65 warning requirements (see Section 8.3).

The following assumptions may be used in assessing whether emissions from the product exceed the SELs:

- Exposure durations are assumed to be for 52 years (commercial) and 70 years (residential).
- Exposures are calculated using a time-weighted average over the durations defined above, and account for dissipation of the chemical emission with time. Whenever possible, the decay rate and the half-life of the chemical emissions from a particular product should be included in the calculations.
- Commercial exposure is assumed to occur 10 hours/day, 5 days/week (residential exposures are assumed to occur 24 hours/day, 7 days/week).
- Average breathing rates for adults (20 m^3/day), young children (5 m^3/day), and adolescents (10 m^3/day) are assumed.

8.3 Proposition 65 Chemicals

Many carcinogens and reproductive toxicants that are found in building products are Proposition 65 chemicals. Section 01350 does not deal with the Proposition 65 warning requirements. This is a separate legal issue, and manufacturers should consult with their legal departments on their products compliance.

8.4 Additional Chemicals of Interest

The California Building Materials Emissions Study [available at http://www.ciwmb.ca.gov/GreenBuilding/Specs/Section01350/METStudy.htm] studied the emissions of VOCs from 77 building materials. The most common VOCs of potential concern found in that study, other than those with Section 01350 concentration limits, are presented in the following table (see next page). The primary effects are due to sensory irritation, odor, and reproductive toxicity. The suggested IAQ performance indicators shown in the table were developed from existing literature (see short explanations and cited references).

Table 8.1. Additional Compounds not currently on the CREL list

Substance	CAS No.	IAQ Performance Indicator Limits ($\mu g/m^3$)	Primary effect
Caprolactam	105-60-2	100	Irritant compound[11]
2-Ethylhexanoic acid	149-57-5	25	Irritant compound[12]
1-Methyl-2-pyrrolidinone	872-50-4	160	Prop 65 reproductive toxicant[13].
Nonanal	124-19-6	13	Odorous compound[14]
Octanal	124-13-0	7.2	Odorous compound[14]
4-phenylcyclohexene	4994-16-5	2.5	Odorous compound[15]

[11] The National Institute for Occupational Safety and Health (NIOSH) has established a limit for vapor caprolactam at 0.22 ppm (1 mg/m^3) for industrial workplaces (see http://www.cdc.gov/niosh/npg/npgd0097.html). The IAQ performance indicator limit cited here was established by applying a ten-fold safety factor of this industrial exposure values to the general population. This extrapolated concentration is an interim concentration limit; at this time OEHHA is in the process of performing a health hazard assessment for this chemical.

[12] 2-ethyl hexanoic acid is a potent eye and throat irritant and a metabolite of a widely used plasticizer. This is a C_8 straight-chain carboxylic acid; such chemicals generally have odor thresholds of the same order as their straight-chain isomers. For comparison, the odor threshold for octanoic acid is approximately 25 ug/m^3.

[13] Concentration based on Maximum Allowable Dose Level for inhalation of 3,200 µg/day (http://www.oehha.ca.gov/prop65/law/pdf_zip/NMPMADL31403.pdf) and an inhalation rate of 20 m^3/day.

[14] Devos M, Patte F, Rouault J, Laffort P, and Van Gemert LJ.. *Standardized Human Olfactory Thresholds*. New York: Oxford University Press, 1990.

[15] Van Ert MD, Clayton JW, Crabb CL, and Walsh DW. *Identification and characterization of 4-phenylcyclohexene—an emission product in new carpeting*. U.S. EPA-Office of Technical Services (OTS) report. January, 1987.

SECTION 9

ACCEPTABLE EMISSIONS TESTING FOR CARPET

Section 01350 / CRI Green Label Plus

Updated June 9, 2004

Below are the changes that the Sustainable Building Task Force, through DHS/IAQ, as its representative, recommends that CRI incorporate to improve its existing "Green Label" Testing Program – Carpet Criteria. Furthermore, given the evolving nature of such a program, we recommend a continued relationship and evaluation between the Sustainable Building Task Force and CRI to create a "Green Label Plus" Testing Program as outlined below:

1. First time test for all carpets:

    a. Conduct full 14-day test using the test protocol and list of chemicals as described in Section 01350 for all carpets as a condition of earning the *Green Label Plus*. In addition the following chemicals and concentrations should be met:

    Caprolactam: 100 µg/m^{3*}
    2-Ethylhexoic acid: 25 µg/m^3
    1-methyl-2-pyrrolidinone: 160 µg/m^{3**}
    Nonanal: 13 µg/m^3
    Octanal: 7.2 µg/m^3
    4-Phenylcyclohexene: 2.5 µg/m^3
    Styrene: 220 µg/m^3

    b. When conducting the 14-day test, collect an additional data point at 1-day (24-hr) after start of conditioning for all individual chemicals as described in Section 01350. Based on this information, show chemical-specific correlation of a least-squares-fit of the 1-day and 14-day emission rates. In addition, based on the 14-day test results as new chemicals may emerge, expand the list of target chemicals of the *Green Label Plus* Testing Program for future 1-day tests as discussed under Item 4b.

    c. The following assumptions may be used in assessing whether emissions from a product exceed the Proposition 65 Safe Harbor Levels or other calculated "interim safe levels":

    - Exposure durations are assumed to be for 52 years.
    - Exposures are calculated using a time-weighted average over the duration defined above, and account for dissipation of the chemical emission with time.
    - New carpets are assumed to be installed every 7 years.
    - Exposure is assumed to occur 10 hours/day, 5 days/week.

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[*] Based on OEHHA's interim REL. CRI and DHS/IAQ will review the limit of this chemical for the Green Label Plus Program when OEHHA issues either an indoor REL or a chronic REL for this chemical

[**] Prop 65 reproductive toxicant. Concentration based on Maximum Allowable Dose Level for inhalation of 3,200 µg/day (http://www.oehha.ca.gov/prop65/law/pdf_zip/NMPMADL31403.pdf) and an inhalation rate of 20 m^3/day

- Average breathing rates for adults are assumed to be 20 m^3/day. Therefore for a 10-hr workday a breathing rate of 10/24 x 20 = 8.3 m^3 can be used.

Note: The assumptions above are not necessarily consistent with those in the Proposition 65 regulation.

2. For all reformulated products conduct 1-day and 14-day tests, using the test protocol and list of chemicals as described in Section 01350 and Item 1a above.

3. Identify any biocide or fire retardant [***] added to the carpet or any change in the biocide or fire retardant used in carpets receiving or renewing the *Green Label Plus* label.

4. Following the initial full 14-day test using the test protocol and list of chemicals as described in Section 01350 and Item 1a and on an annual basis thereafter, perform modified Section 01350 testing as follows:

   a. Conduct a 24-hour emissions test for the following target chemicals with the following target air concentrations:

      Acetaldehyde: 4.5 μg/m^3
      Benzene: 30 μg/m^3
      Caprolactam: 70 μg/m^3[****]
      2-Ethylhexoic acid: 25 μg/m^3[*****]
      Formaldehyde: 16 μg/m^3
      1-methyl-2-pyrrolidinone: to be determined
      Naphthalene: 4.5 μg/m^3
      Nonanal: 13 μg/m^3
      Octanal: 7.2 μg/m^3
      4-Phenylcyclohexene: 2.5 μg/m^3[*****]
      Toluene: 150 μg/m^3
      Styrene: 220 μg/m^3
      Vinyl acetate: 100 μg/m^3

   b. The above list will be reviewed annually and revised as needed by the scientific team agreed upon by CRI and DHS/IAQ.- Also see Item 1b above.
   c. Using the 24-hour test data and the agreed upon correlation model for caprolactam, extrapolate the results to the 14-day point.

[***] By law, use of polybrominated diphenyl ethers (PBDEs) is banned in California effective January 1, 2008 (California Health and Safety Code, Section 108920-108923 as amended by AB 2587, Chan, 2004)
[****] This corresponds to emission factor of 130 μg/m^3 for the standard office application as described under Item 5 of this agreement and it is based on modeling using OEHHA's current interim chronic REL of 100 μg/m^3 at 14 days. CRI and DHS/IAQ will review the limit of this chemical for the Green Label Plus Program when OEHHA issues either an indoor REL or a chronic REL for this chemical
[*****] These values will be reviewed and may be changed based on data developed under Item 1b. CRI and DHS/IAQ will mutually agree on this approach.

5. Finding any new chemicals in the products tested under Steps 1 or 2 above that cannot be modeled to the 14-day point using the 24-hr test data as described in Item 4 above, would result in either: (a) an annual test using the full 14-day protocol; or (b) the utilization of specific analytical methods targeting the chemical(s) under question. The advisory team discussed under Item 8 would advise CRI on what approach is most appropriate.

6. All calculated concentrations under Steps 1, 2, and 4 above shall be done using a standard office space (10 x 12 x 9 ft) and default ventilation rate (0.75 hr^{1}). Calculated air concentrations of target compounds shall not exceed those specified in Section 01350 and those listed under Item 1a for the 14-day test or those listed under Item 4a for the 24-hr test.

7. Although not required by DHS/IAQ, CRI may choose for quality assurance purposes, to perform limited TVOC screening emissions tests on a quarterly basis.

8. CRI will assemble a team of recognized scientists with expertise in indoor air quality, risk assessment and modeling to review all the information developed under Steps 1, 2, and 4 above. The proposed list of the names of these experts needs to be mutually agreed upon.

9. As part of the *Green Label Plus* Testing Program, CRI will develop and maintain a database with all the emissions data for all the carpets receiving this label. Emission rates of chemicals tested under the full 14-day test protocol (as described in Items 1 and 2) as well as under the modified testing protocol described under Item 4 above, shall be made available to carpet specifiers, under a confidentiality agreement.

10. The DHS/IAQ agrees to incorporate into future revision(s) of Section 01350 that the CRI *Green Label Plus* program is acceptable in lieu of Section 01350 with respect to VOC emissions testing of carpets. The DHS/IAQ reserves the right to withdraw language in reference to the fact that the *Green Label Plus* is acceptable in lieu of Section 01350, if any of the requirements agreed upon between both parties are not implemented on a continuous basis. In such case, the DHS/IAQ agrees to provide a written request to CRI asking for their compliance. If such compliance cannot be proven to the satisfaction of the DHS/IAQ within 30 days, language referring to the acceptability of the *Green Label Plus* in lieu of Section 01350 will be withdrawn.

11. The Sustainable Building Task Force agrees, upon request by CRI, to notify current user(s) of 01350 when their products have been tested and passed the *CRI Green Label Plus* Testing Program that this Label is equivalent to 01350. Such notifications would not be necessary after this equivalency is incorporated into Section 01350.

12. Any modifications to Section 01350 for carpeting would not be automatically applicable to other building materials, including other components of carpet assemblies such as adhesives and cushions, unless a dialogue and review process similar to the one with CRI takes place.

13. Air Quality Sciences (AQS), the official testing laboratory for the Green Label Program, worked with the DHS/IAQ, which conducted an informal review of their quality assurance and laboratory procedures. As state resources allow, DHS/IAQ will continue to work with AQS on an informal basis to address any concerns that may arise during this process. The agreement with CRI may be terminated by the DHS/IAQ, if the quality assurance and laboratory procedures of AQS cannot be reasonably assessed, or deficiencies, if any, cannot be resolved within a reasonable timeframe.

14. CRI's existing product categories that were developed based on the backing and fiber types will continue as such. These categories will be re-evaluated on a yearly basis as more data are compiled.

15. CRI will meet with the representatives of the DHS/IAQ and their consultants annually to provide status of the *Green Label Plus* Testing Program, and to discuss and resolve issues. During the transition between current Green Label and its enhanced version, CRI will maintain both labels until all products have been tested under the new enhanced protocol.

16. CRI agrees to continue using the caprolactam model (per Item 4c) developed by CRI's consultant Mr. Bruce Tichenor and agreed upon with the DHS/IAQ.